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RECENTLY PUBLISHED RESEARCH OF THE HIGHER MILITARY-PEDAGOGICAL INSTITUTE IMENI KALININ, LENINGRAD

"Effect of the Supersonic Field on the Crystallization of Undercooled Liquids," R. Ya. Berlaga

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High-frequency vibrations from 5×10^5 to 5×10^7 hertz 150-200 w at the actually used frequency of 6×10^6 were impressed upon a piezoelectric quartz plate cut perpendicular to its electric axis, 2 x 25 x 30 mm. The substance investigated, salol, was heated somewhat above its mp (42.6°) in a flattened glass tube with polished plane bottom, provided with equidistant gradation marks, undercooled to room temperature and inoculated at one end with a crystallization germ. Linear progress of crystallization was observed under the microscope, visually, photographically, and with the aid of photocell recording, with the glass tube placed on top of the quartz vibrator, with the supersonic generator off and on. The simplest type of vibrator, consisting of the quartz plate with 0.2-mm metal foil electrodes applied on both faces and immersed in an oil bath, gave reduced linear rates of crystallization in a supersonic field, up to 50% (2.4×10^{-3} cm/sec as against 4.7×10^{-3} without field) in strong fields at 6×10^6 hertz. This observation was demonstrated to be entirely due to the heating effect of the vibrations. This effect was reduced with a second type of vibrator in which the quartz plate is cooled in flowing oil. With adequate cooling, checked with the aid of thermocouple probes, the effect is reversed, that is the supersonic field causes an increase in the rate of crystallization, e.g., from 4.7×10^{-3} to 5.5×10^{-3} cm/sec; in this case, the opposing heating effect is strongly reduced but not altogether suppressed. The residual heating effect

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was eliminated with a third type of vibrator the lower electrode of which is hollow (air cushion), with both the vibrator and the crystallization tube bathing in flowing oil, and observation of the progress of the crystallization front between successive marks distant at 1 cm, first with the field on and then off; this procedure is shown to eliminate the secondary heating effect completely. The pure effect of the supersonic field, with salol preparations 1.5-2.0 cm long, rate of crystallization without field about 6×10^{-3} cm/sec, was found to attain 270% with a high-frequency voltage of 830 v, and 1500% with 1,000 v at room temperature. The effect on the number of crystallization centers was studied on preparations of betol, melted at 93°, then kept at room temperature for 20 minutes during which time the crystallization centers appeared, then again heated at 75° and viewed under a microscope. The ultrasonic field was applied at the stage of formation of the centers. Spherolites, which in the absence of the field are ordinarily fine-grained, grow faster and are more coarse-grained under the action of the supersonic field; with the field off and on alternatively, the spherolites show concentric darker and lighter rings. In weak fields, additional centers appear only occasionally but strong fields give rise to the formation of new centers at some distance from the original spherolite. The global effect of the supersonic vibrations is composed of an increase in the number of centers and of an increased rate of linear crystallization. With a betol preparation having two crystallization centers, crystallization of the whole sample was completed, in a supersonic field of 1,000 v, in 1 minute, 45 seconds, as against 17 minutes without field.

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